

A review of the pseudoscorpion genus *Oreolpium* (Pseudoscorpiones: Garypinidae), with remarks on the composition of the Garypinidae and on pseudoscorpions with bipolar distributions

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Abstract. A review of the pseudoscorpion genus *Oreolpium* Benedict & Malcolm reveals two species, the type species *O. nymphum* Benedict & Malcolm 1978 from northwestern USA and *O. semotum*, new species, from southern Tasmania. *Oreolpium* is most similar to *Neomimmiza* Beier, *Thaumatolpium* Beier and *Teratolpium* Beier from South America, and to *Protogarypinus* Beier from southern Australia. These genera are confirmed as members of Garypinidae, and both species of *Oreolpium* are found to lack glandular setae on sternites VI–VIII, which is an unusual feature for Garypinidae. *Oreolpium* demonstrates a remarkable bipolar distribution, similar to that of the pseudoscorpion groups Pseudotyranochthoniidae, Pseudogarypinidae and Syarininae, and to several water mite taxa.

Keywords: Biogeography, Pangaea, new species, taxonomy

The discovery of the pseudoscorpion *Dracochela deprehendor* Schawaller, Shear & Bonamo 1991 and other arachnids from the Devonian represented a quantum shift in evolutionary studies with the Arachnida, extending the fossil record of most major arachnid lineages to the Paleozoic (Hirst 1923; Hirst & Maulik 1926; Shear et al. 1987; Norton et al. 1988; Kethley et al. 1989; Shear et al. 1989a; Shear et al. 1989b; Shear & Kukalová-Peck 1990; Schawaller et al. 1991; Selden et al. 1991). Whilst *D. deprehendor* could not be assigned to a living family, many of the Mesozoic pseudoscorpions recorded from Cretaceous deposits can be readily assigned to modern families, including Garypinidae (Judson 1997), Cheiridiidae (Judson 2000) and Chernetidae (Schawaller 1991), highlighting that many pseudoscorpion families can trace their origins to at least the Cretaceous. Current hypotheses on the positions of continental blocks during the Mesozoic indicate that after the Jurassic, when the continents were largely coalesced into a single supercontinent Pangaea, the continents fragmented and dispersed (Smith et al. 1994). The continental fragments took with them life forms, many of which have survived to the present. With the majority of the pseudoscorpion families presumably extant by the end of the Mesozoic, it is likely that traces of their past distributions can be discerned if vicariance, rather than dispersal, has occurred (Nelson & Platnick 1981).

Harvey (1998b) documented two distinct pseudoscorpion clades with bipolar distributions – taxa found in the temperate regions of the Holarctic and Gondwanan realms but without any records from intervening regions. The family Pseudogarypinidae is currently known from seven Recent species in North America and Tasmania (e.g., Benedict & Malcolm 1978a; Muchmore 1981a; Harvey 2009) and four Tertiary fossil species from European Baltic amber (Beier 1937, 1947; Henderickx et al. 2006). The subfamily Syarininae (a member of the neobisoid family Syarinidae) contains six Recent species of *Syarinus* Chamberlin 1930 in North America and Europe (e.g., Mahnert 1976a; Schawaller 1987; Schmarida 1997; Ducháč 1998; Harvey 2009) and two species of *Anysrius* Harvey 1998 in Tasmania (Harvey 1998b, 2009). The

chthoniid subfamily Pseudotyranochthoniidae also seems to have a bipolar distribution with some found in extreme southern latitudes (*Pseudotyranochthonius* Beier 1930 in Australia and Chile, and *Afrochthonius* Beier 1930 and *Selachochthonius* Chamberlin 1929 in southern Africa) and others found in northern latitudes (*Pseudotyranochthonius* in East Asia and western North America, *Allochthonius* Chamberlin 1930 in East Asia, and *Centrochthonius* Beier 1931 in Central and East Asia) (see Harvey 2009). The anomalous presence of two species of *Afrochthonius* in Sri Lanka (Beier 1973) may be the result of vicariance when the Indian subcontinent broke away from Gondwanaland during the late Cretaceous (e.g. Besse & Courtillot 1988; Smith et al. 1994; Scotese 2001).

Recently another pseudoscorpion taxon displaying evidence of bipolar distributions has emerged with the discovery of a small, peculiar pseudoscorpion from southern Tasmania. Initial study of this species suggested a similarity with the genus *Oreolpium* Benedict & Malcolm 1978, only known from the species *O. nymphum* Benedict & Malcolm 1978 from corticolous habitats in northwestern USA (e.g. Benedict & Malcolm 1978b), originally referred to the olpiid subfamily Olpiinae. A reappraisal of the North American species confirmed that the Tasmanian species is indeed congeneric with *O. nymphum*, which shares a number of morphological features with four genera from South America (*Neomimmiza* Beier 1930, *Teratolpium* Beier 1959 and *Thaumatolpium* Beier 1931) and Australia (*Protogarypinus* Beier 1954). We here present a review of *Oreolpium* and the two known species, and assess their relationships.

METHODS

The material examined in the present study is lodged in the American Museum of Natural History, New York (AMNH); California Academy of Science, San Francisco (CAS); Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ); Natural History Museum, Vienna (NHMW); Tasmanian Museum and Art Gallery, Hobart (TMAG); and Western

Australian Museum, Perth (WAM). Details of the specimens examined are provided in Appendix 1. Terminology and mensuration mostly follow Chamberlin (1931), with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992) and chelicera (Judson 2007).

Specimens studied by MSH were examined with an Olympus BH-2 compound microscope and those studied by FS were examined with a Leica MZ125 stereomicroscope and a Leitz Diaplan microscope. The illustrations were prepared with the aid of a drawing tube fitted to the Olympus microscope. Measurements were taken at the highest possible magnification using an ocular graticule and are presented in mm. The Tasmanian specimens were examined by preparing temporary slide mounts by immersing the specimens in 75% lactic acid at room temperature for several days and mounting them on microscope slides with 10 or 12 mm coverslips supported by small sections of 0.25 mm or 0.50 mm diameter nylon fishing line. After study the specimens were returned to 75% ethanol with the dissected portions placed in 12 × 3 mm glass genitalia microvials (BioQuip Products, Inc.). Some of the type specimens of *Oreolpium nymphi* were originally mounted on microscope slides in Hoyer's medium by E. Benedict or D. Malcolm. Unfortunately the mountant has dried and contracted, probably due to the lack of a suitable ring compound around the edge of the coverslip, compressing the specimen and the dissected parts such that detailed examination was impossible. Some of these slides were soaked in warm distilled water until the mountant became pliable. The pieces of the specimen were removed from the mountant with fine forceps, rinsed in clean distilled water and transferred to concentrated detergent (Extran 100[®]). After 10–20 min in detergent the pieces were returned to water where the crushed segments returned to their approximate original shape.

SYSTEMATICS

Family Garypinidae Daday 1888

Garypininae Daday 1888:123, Chamberlin 1930:590–591, Chamberlin 1931:225, Beier 1932: 203, Roewer 1937:263, Hoff 1956:27, Morikawa 1960:129, Hoff 1964:35, Benedict & Malcolm 1978:124, 125, Muchmore 1980:165, Tooren, 2002:470.

Garypinidae Daday: Judson 2005:128.

Remarks.—Since its inception as a family (Chamberlin 1930), the Olpiidae has included two subfamilies, Olpiinae and Garypininae, differing by the morphology of the arolia (not divided in olpiines and divided in garypinines), the tergites (not divided in olpiines and at least some divided in garypinines) and the rallum (two or three blades in olpiines, four blades in garypinines). The Garypininae were treated by Daday (1888) as a subfamily of the Cheliferidae, along with the Cheliferinae and Garypinae, and although he noted the strongly divided arolium in the only included species *Garypinus dimidiatus* (L. Koch 1873), he focused on characters such as the presence of a cheliceral galea, the absence of an epistome on the carapace, the presence of a single furrow on the carapace, the number of eyes and the leg segmentation to segregate the garypinines from the other subfamilies. Apart from the divided arolium, these features are no longer used to

define the group. Recently, the garypinines were treated as a separate family from Olpiidae (Judson 1992a, 1993, 2005). In addition to features traditionally used to support the garypinines, Judson (2005) added two character states to support the assignment of the Tertiary fossil *Garypinus electri* Beier 1937 to the Garypinidae: paraxially offset chelal pedicel, and the basal concentration of the trichobothria of the internal series. Looking outside of the Garypinidae, it is apparent that these features are not totally restricted to members of the family, with members of the ideoroncid genus *Albiorix* Chamberlin 1930 also bearing divided arolia, all sternophorids bearing an offset pedicel, and many different pseudoscorpion taxa with basally concentrated internal trichobothria. Indeed, the last two features are not found in all garypinids, as the pedicel is not paraxially offset in *Garypinus afghanicus* Beier 1959 (Beier 1959b, figs. 11, 12), *Garypinidius mollis* Beier 1955 (Beier 1955, fig. 10) or *Serianus galapagoensis* Beier 1978 (Beier 1978, fig. 3) and the internal trichobothria are not always grouped basally, as all described species of *Amblyolpium* Simon 1898 and *Neoamblyolpium* Hoff 1956 clearly have three of these trichobothria situated medially on the internal margin of the chelal finger (e.g., Beier 1932; Hoff 1956; Beier 1959c; Morikawa 1960; Beier 1966b, 1967b, 1970b, 1970a; Heurtault 1970; Lazzeroni 1970; Beier 1971; Mahnert 1976b; Muchmore 1980; Harvey 1988; Tooren 2002).

In addition to the genera traditionally assigned to the Garypininae, several genera originally attributed to the Olpiidae have basally located internal trichobothria with all four trichobothria situated on the internal face of the chela: *Neominniza* from Chile; *Oreolpium* from Oregon, USA; *Protogarypinus* from Australia; *Teratolpium* from Peru; and *Thaumatolpium* from Chile (e.g. Beier 1954, 1959c, 1964, 1975; Benedict & Malcolm 1978b). Of these genera, all except *Neominniza* and *Thaumatolpium* bear the offset pedicel and all of these genera possess divided or at least partially divided tergites (regrettably, the published descriptions of several species fail to specifically mention this feature). Whilst many species of these genera have been reported to have four blades in the rallum, *Teratolpium andinum* Beier 1959 (the sole member of the genus), was reported as possessing only three blades (Beier 1959c), but we were unable to confirm this feature during our examination of specimens of *T. andinum*. Members of these genera lack the divided arolium, which has traditionally served to define the group (e.g. Chamberlin 1930; Beier 1932). As noted below, we believe that these genera are best included in Garypinidae, rather than Olpiidae, as they share several major character states with garypinids.

In addition to the features listed above that serve to define the Garypinidae, most garypinids bear at least one pair of conspicuous glandular setae on the medial portion of the medial sternites slightly forward of the regular setal row, and they may exhibit sexual dimorphism in their shape and size, being slightly smaller in females. A single pair of glandular setae on the medial region of sternites VI, VII and VIII occur in species currently assigned to the following genera: *Aldabrinus* Chamberlin 1930 (Muchmore 1974), *Galapagodin* Beier 1978 (Beier 1978), *Garypinidius* Beier 1955, *Garypinus* Daday 1888 (Hadži 1933; Mahnert 1988), *Haplogarypinus* Beier 1959 (Beier 1959a), *Hemisoliinus* Beier 1977 (Beier 1977), *Indogarypinus* Murthy and Ananthakrishnan

1977 (Murthy & Ananthkrishnan 1977), *Nelsonimus* Beier 1967 (Beier 1967a), *Neominniza* (Beier 1964), *Paraldabrinus* Beier 1966 (Beier 1966b), *Protogarypinus dissimilis* Beier 1975, some species of *Serianus* Chamberlin 1930 (Chamberlin 1930; Beier 1964, 1966a; Mahnert 1988), *Solinellus* Muchmore 1979 (Muchmore 1979), *Solinus* Chamberlin 1930 (Dashdamirov 1996) and *Thaummatolpium* (Beier 1964). Variant morphologies occur in some species of *Serianus* where sternites VI–VII possess multiple glandular setae arranged in two groups and sternite VIII bears paired setae (e.g., Chamberlin 1930; Hoff 1956; Beier 1959c; Hoff 1964; Muchmore 1968; Mahnert 1988), or where sternites VI–VIII each bear a median group of four setae (Muchmore 1981b). Similarly, males, females and nymphs of *Protogarypinus giganteus* Beier 1954 bear multiple glandular setae arranged in two groups on sternites VI, VII and VIII (Harvey personal observation). Species of *Amblyolpium* bear a single pair of glandular setae only on sternites VI and VII, with such setae absent from sternite VIII (e.g., Chamberlin 1930; Beier 1966b, 1970b, 1970a; Heurtault 1970; Beier 1971; Mahnert 1976b; Harvey 1988). Sternal glandular setae are definitely absent in *Pseudogarypinus costaricensis* Beier 1931, *P. frontalis* (Banks 1909) and *P. cooperi* Muchmore 1980 (Harvey & Štáhlavský, personal observations), and these observations accord with the lack of any mention of these distinctive setae in modern descriptions of species of *Pseudogarypinus* (e.g. Hoff 1961; Benedict & Malcolm 1978b; Muchmore 1980). They are also absent in males and females of *Neoamblyolpium alienum* Hoff 1956 from western USA (Harvey personal observation) and in *Teratolpium andinum* Beier 1959 (Štáhlavský personal observation). Of the remaining genera attributed to the Garypinidae, the recent description of *Caecogarypinus* Dashdamirov 2007 failed to mention the presence or absence of glandular setae (Dashdamirov 2007). Conspicuous glandular setae are found in a variety of different pseudoscorpions (Judson 1992b), including some members of the Neobisiidae, Syarinidae, Geogarypidae, Garypinidae and Withiidae.

A further feature found in many garypinids but absent from olpiids is the paired and enlarged dorsal anterior glands of the male genital system. These have been found in species of *Aldabrinus* (Muchmore 1974), *Amblyolpium* (Harvey 1988), *Pseudogarypinus* (Muchmore 1980), *Serianus* (Chamberlin 1923; Hoff 1956; Muchmore 1980; Mahnert 1991), *Solinellus* (Muchmore 1979) and *Solinus* (Chamberlin 1923; Dashdamirov 1996) and observed in males of *Galapagodinus* sp., *Neoamblyolpium alienum*, *Neominniza* sp., *Pseudogarypinus frontalis*, *Protogarypinus giganteus*, *Serianus argentinae* Muchmore 1981, *S. dolosus* Hoff 1956, *S. gratus* Hoff 1964, *S. minutus* (Banks 1908), *Solinus* sp. and *Thaummatolpium* sp. (Harvey personal observations). They are clearly absent in *O. nymphum* and *O. semotum* (Figs. 9, 20). We were unable to confirm the presence of these glands in *Teratolpium*, the other putative relative of *Oreolpium*. Similar enlarged glands are present in a few other garypoid genera such as the two genera of Larcidae, *Larca* Chamberlin 1930 and *Archeolarca* Hoff & Clawson 1952 (Harvey personal observation), but appear to be absent from all other garypoids including all members of the Garypidae, Olpiidae and Menthididae (e.g., Vachon 1938; Muchmore 1979; Harvey 1987b; Harvey & Muchmore 1990) (Harvey personal observation).

Therefore, we propose that the Garypinidae and Olpiidae be defined as follows:

Garypinidae: Trichobothrium *isb* (when present) on internal margin of chelal fingers, tergites and sternites usually divided or partly divided, cheliceral rallum of four blades (but apparently only three blades in *Teratolpium*), median sternites usually with conspicuous glandular setae (absent in *Neoamblyolpium*, *Oreolpium*, *Pseudogarypinus* and *Teratolpium*), arolium usually divided (but not divided in *Neominniza*, *Oreolpium*, *Protogarypinus*, *Teratolpium* and *Thaummatolpium*), chela with paraxially offset pedicel (except in *Neominniza* and *Thaummatolpium*), male genitalia with paired and enlarged dorsal anterior gland (except in *Oreolpium*). See Table 1 for a list of genera included within the Garypinidae.

Olpiidae: Trichobothrium *isb* on external margin of chelal fingers; tergites and sternites not divided; cheliceral rallum of three blades, occasionally reduced to two blades (*Neopachyolpium*, *Aphelolpium* and *Planctolpium*); median sternites without conspicuous glandular setae; arolium not divided; chela without paraxially offset pedicel; male genitalia without paired and enlarged dorsal anterior gland. The majority of features used to diagnose the Olpiidae do not, however, appear to be synapomorphic, as all of the character states listed above are generally plesiomorphic within the Garypoidea. A list of genera included in Olpiidae is provided by Harvey and Leng (2008).

There is some evidence that garypinids might not be the sister-group to the Olpiidae, despite their long association with each other within the same family. The movement of trichobothrium *isb* onto the internal margin of the fixed chelal finger is also found in all species of the garypoid families Larcidae and Geogarypidae (Harvey 1990, 1992), and the presence of glandular setae on the median sternites is also found in at least some Geogarypidae (Judson 1992b). A recent molecular phylogeny of the Pseudoscorpiones using two nuclear ribosomal genes and one mitochondrial protein-encoding gene found the two garypinids used in the analysis (*Protogarypinus giganteus* and *Pseudogarypinus cooperi*) to nest with *Larca lata* (Hansen 1894) (Larcidae), the neobisioid *Syarinus* sp. (Syarinidae) and the cheliferoid *Neochelanops* sp. (Chernetidae), a very bizarre arrangement given that *Syarinus* and *Neochelanops* have never previously been considered garypoids. These incongruent data suggest that different markers and a greater array of taxa are required to fully assess the relationships of the garypinids.

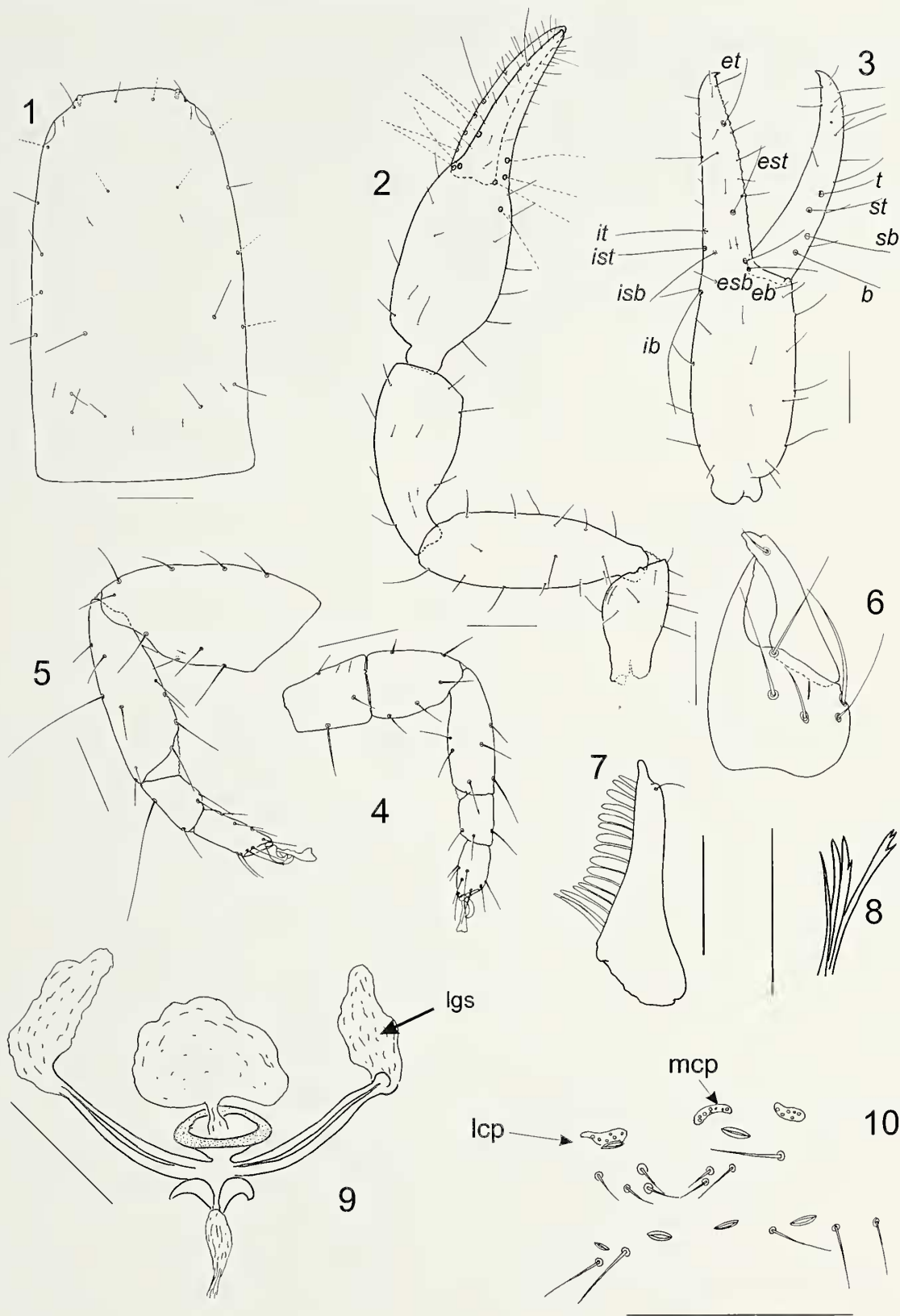
Oreolpium Benedict & Malcolm 1978

Oreolpium Benedict & Malcolm 1978:120, Harvey 1991:294, Harvey 2009:[unpaginated].

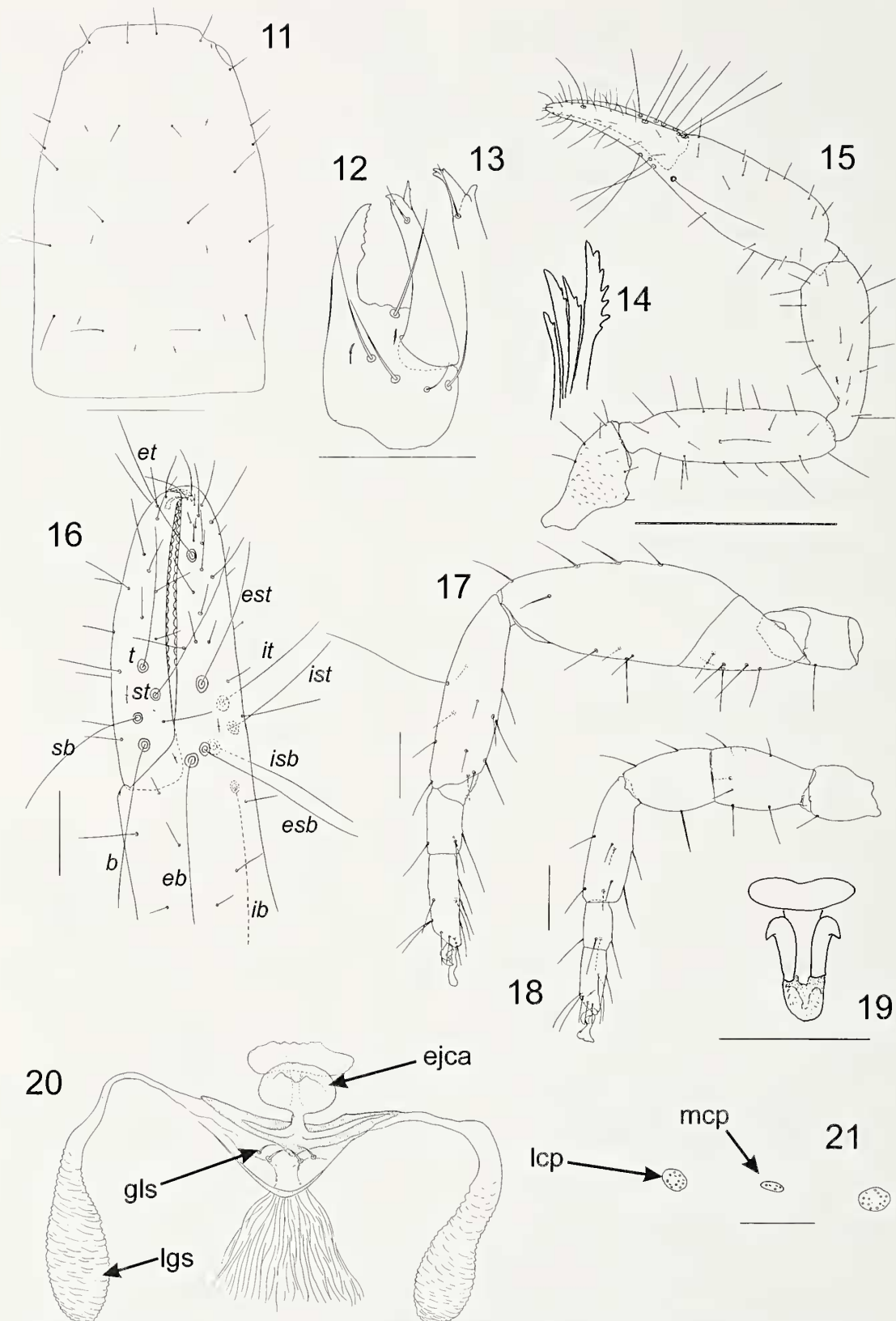
Type species.—*Oreolpium nymphum* Benedict & Malcolm 1978, by original designation.

Diagnosis.—A genus of Garypinidae with the following combination of characters: sternal glandular setae absent; male genitalia without paired dorsal anterior glands; carapace with 1 small pair of eyes and 20–22 setae; cheliceral hand with 5 setae; rallum of 4 blades, all denticulate; pedipalpal femur with 1 or 2 tactile setae; chela with paraxially offset pedicel; arolium much longer than claws, not divided.

Description.—*Chelicera:* With 5 setae on hand, all setae acuminate; movable finger with 1 subdistal seta; subterminal



Figures 1–10.—*Oreolpium nymphum* Benedict & Malcolm 1978: 1. Carapace, dorsal aspect, female paratype (CAS, EB-1634.01002); 2. Left pedipalp, dorsal aspect, female paratype (CAS, EB-1503.01004); 3. Right chela, lateral aspect, female paratype (CAS, EB-1503.01004); 4. Leg I, lateral aspect, female paratype (CAS, EB-1634.01002); 5. Leg IV, lateral aspect, female paratype (CAS, EB-1634.01002); 6. Right chelicera, dorsal aspect, male paratype (CAS, EB-1503.01003); 7. Movable cheliceral finger, lateral aspect, female paratype (CAS, EB-1506.01001); 8. Right rallum, lateral aspect, female paratype (CAS, EB-1558.02003); 9. Male genitalia, ventral aspect, male paratype (CAS, EB-1503.01003); 10. Female genitalia and sternites, ventral aspect, female paratype (CAS, EB-864.01001). Abbreviations: lcp, lateral cribriform plate; lgs, lateral genital sac; mcp, median cribriform plate. Scale lines = 0.1 mm (Figs. 1–5, 10), 0.04 mm (Fig. 6); 0.05 mm (Figs. 7, 9).



Figures 11–21.—*Oreolpium semotum* new species, male holotype unless stated otherwise: 11. Carapace, dorsal aspect; 12. Right chelicera, dorsal aspect; 13. Tip of movable cheliceral finger and galea, dorsal aspect, female paratype; 14. Right rallum, lateral aspect; 15. Right pedipalp, dorsal aspect; 16. Left chela, lateral aspect; 17. Left leg IV, lateral aspect; 18. Left leg I, lateral aspect; 19. Claws and arolium, ventral aspect, female paratype; 20. Male genitalia, ventral aspect; 21. Female genitalia, ventral aspect, female paratype. Abbreviations: ejca, ejaculatory canal atrium; gls, glandular setae; lcp, lateral cribriform plate; lgs, lateral genital sac; mcp, median cribriform plate. Scale lines = 0.05 mm (Figs. 19, 21), 0.1 mm (Figs. 12, 16–18), 0.2 mm (Fig. 11), 0.5 mm (Fig. 15).

Table 1.—List of genera of Garypinidae, with numbers of named Recent species and distributions.

Genus	No. of named species	Distribution
<i>Aldabrinus</i> Chamberlin 1930	2	Seychelles (Aldabra Islands); southeastern USA
<i>Amblyolpium</i> Simon 1898	14	Asia; northern Africa; Caribbean region; South America; New Caledonia; Papua New Guinea; Solomon Islands; Mediterranean region
<i>Caecogarypinus</i> Dashdamirov 2006	1	Vietnam
<i>Galapagodinus</i> Beier 1978	1	Ecuador (Galapagos Islands)
<i>Garypinidius</i> Beier 1955	2	South Africa
<i>Garypinus</i> Daday 1888	6	South Africa; western and southeastern Asia; Hawaii; Mediterranean region
<i>Haplogarypinus</i> Beier 1959	1	Democratic Republic of Congo (Zaire)
<i>Hemisolinus</i> Beier 1977	1	Saint Helena
<i>Indogarypinus</i> Murthy and Ananthkrishnan 1977	1	India
<i>Nelsoninus</i> Beier 1967	1	New Zealand
<i>Neoamblyolpium</i> Hoff 1956	2	Southwestern USA
<i>Neominniza</i> Beier 1930	2	Chile
<i>Oreolpium</i> Benedict and Malcolm 1978	2	Western USA; Australia (Tasmania)
<i>Paraldabrinus</i> Beier 1966	1	New Caledonia
<i>Protogarypinus</i> Beier 1954	2	Australia
<i>Pseudogarypinus</i> Beier 1931	4	Western USA; Costa Rica
<i>Serianus</i> Chamberlin 1930	18	Northern Africa; North and South America; Arabian Peninsula; central Asia; Solomon Islands
<i>Solinellus</i> Muchmore 1979	1	Southeastern USA
<i>Solinus</i> Chamberlin 1930	9	Eastern Africa; Central America; central Asia; Australia; Papua New Guinea; Mediterranean region
<i>Teratolpium</i> Beier 1959	1	Peru
<i>Thaumatolpium</i> Beier 1931	5	Chile

tooth of movable finger not bifurcate and not enlarged; rallum of 4 denticulate blades; lamina exterior very thin in *O. semotum* and apparently absent in *O. nymphum*.

Pedipalp: Femur with 1 or 2 tactile setae, situated in basal half. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria; *eb* and *esb* situated basally; *est* clearly in basal half of fixed finger, situated closer to *eb* and *esb* than to *et*; trichobothria *ib*, *isb*, *ist* and *it* grouped sub-basally, with *ib* slightly separated from others; trichobothria of movable finger situated in basal half of finger; *st* situated closer to chelal finger margin than *b*, *sb* and *t*. Venom apparatus present in both chelal fingers, venom ducts very short, terminating in nodus ramosus almost immediately.

Cephalothorax: Carapace sub-rectangular; with 1 pair of flat, corneate eyes situated near anterior margin of carapace; with 20–22 setae, including 4 near anterior margin and 4 near posterior margin.

Abdomen: Pleural membrane longitudinally striate. Tergites and sternites with faint medial suture, or with suture apparently absent; glandular setae absent. Spiracular helix present.

Genitalia: Male: dorsal anterior glands absent; lateral genital sacs large; with 2 pairs of internal glandular setae. Female: with paired lateral cribriform plates and single median cribriform plate.

Legs: Junction between femora and patellae I and II broad and apparently sub-mobile; femur I barely longer than patella I; tibiae III and IV with long sub-medial tactile seta; metatarsi III and IV with long subbasal tactile seta; metatarsus and tarsus stocky; arolium much longer than claws, not divided.

Remarks.—*Oreolpium nymphum* and *O. semotum* share a number of similarities: both possess an undivided arolium; a

single sub-medial tactile seta on the pedipalpal femur; 1 pair of eyes; rallum with 4 blades; low numbers of carapaceal seta with 4 on the anterior margin and 4 on the posterior margin (22 setae in *O. semotum* and usually 20–22 setae in *O. nymphum*); the position of trichobothrium *st*, which is situated slightly closer to the dental margin than the other trichobothria on the movable chelal finger; and the lack of abdominal glandular setae. The only obvious discrepancy is the relative lengths of femur and patella of legs I and II. In *O. nymphum* the patella is marginally longer than the femur, whereas in *O. semotum* the femur is slightly longer than the patella, but these differences are extremely trivial and do not necessarily preclude a close relationship between *O. semotum* and *O. nymphum*.

As discussed previously, *Oreolpium* resembles four other garypinid genera (*Neominniza*, *Protogarypinus*, *Teratolpium* and *Thaumatolpium*), in which the arolium is not divided. It is similar to *Thaumatolpium* and *Teratolpium* by the presence of only one pair of eyes; two pairs of eyes are present in *Neominniza* and *Protogarypinus* (Beier 1954, 1964, 1975). It differs from *Neominniza* in that all of the trichobothria of the internal series are basally grouped; in species of *Neominniza* trichobothria *isb*, *ist* and *it* are more medially placed and separated from *ib* (Beier 1964). *Oreolpium* differs from *Thaumatolpium* by possessing fewer setae on the carapace: *Oreolpium* has 20–22 setae, including 4 near the anterior margin and 4 near the posterior margin, while *Thaumatolpium* has 28–32 setae with 6 near the anterior margin and 6 near the posterior margin (Beier 1964). In addition, species of *Thaumatolpium* bear a pair of glandular setae on sternites VI–VIII (Beier 1964), but *O. nymphum* and *O. semotum* lack such glandular setae. It differs from species of *Neominniza* and

Thaumatolpium by the presence of a chela with paraxially offset pedicel (not offset in *Neomimiza* and *Thaumatolpium*). *Oreolpium* differs from *Protogarypinus* by the lack of glandular setae on the abdominal sternites. *Oreolpium* differs from *Teratolpium* by the lack of a heart-shaped median depression on the carapace (Beier 1959c, fig. 8), and the presence of four rallar blades (three in *Teratolpium*).

Oreolpium nymphum Benedict & Malcolm 1978
Figs. 1–10, 21

Oreolpium nymphum Benedict and Malcolm 1978:120–124, figs. 9–14; Zeh 1987:1086; Muchmore 1990:515; Harvey 1991:294; Harvey 2009: [unpaginated].

Material examined.—Paratypes, USA: *Oregon*: 1 female, Douglas County, 8 miles S, 4 mi E of Tiller, ca 42°56'N, 122°57'W, 13 September 1973, E.M. Benedict (CAS, EB-1558.02003); 1 female, Jackson County, 6 mi S, 12 mi W of Ashland, ca 42°12'N, 122°42'W, 17 September 1972, E.M. Benedict (CAS, EB-864.01001); 1 female, Lane County, 4 mi N, 13 mi E of Lowell, ca 43°55'N, 122°47'W, 30 August 1973, E.M. Benedict (CAS, EB-1506.01001); 1 male, same data (CAS, EB-1503.01003); 1 female, same data (CAS, EB-1503.01004); 1 female, same data (CAS, EB-1503.01005); 1 female, Marion County, 5 mi due N of Mill City, ca 44°45'N, 122°29'W, 17 September 1973, E.M. Benedict (CAS, EB-1634.01002).

Diagnosis.—*Oreolpium nymphum* is substantially smaller than *O. semotum*, e.g., pedipalpal femur length 0.33–0.35 (♂), 0.33–0.39 (♀) mm in *O. nymphum* compared with 0.547 (♂), 0.563 (♀) mm in *O. semotum*, and chela (with pedicel) length 0.56–0.59 (♂), 0.62–0.63 (♀) mm in *O. nymphum* compared with 0.802 (♂), 0.845 (♀) mm in *O. semotum*.

Description.—*Adult*: Body strongly flattened. Color with sclerotized portions generally very pale, pedipalps and anterior portion of carapace slightly darker.

Chelicera: With 5 setae on hand, all setae acuminate (Fig. 6); movable finger with 1 subdistal seta (Fig. 7); subterminal tooth of movable finger not bifurcate and not enlarged; with 3 lyrifissures, 2 on dorsal face and 1 on ventral face; galea of ♂ not discernible in only specimen available, of ♀ long with 3 terminal rami; rallum of 4 blades, distal and subdistal blade each with 1 large serration on leading edge (Fig. 8); serrula exterior with 14 blades; lamina exterior apparently absent.

Pedipalp: Trochanter, femur, patella, and chela completely smooth (Fig. 2); setae very long and acicular; trochanter elongate, without any discernible tubercles; trochanter 2.1–2.3 × (♂), 2.3 × (♀), femur 3.6–4.0 × (♂), 3.4–3.9 × (♀), patella 2.6–2.7 × (♂), 2.6–3.0 × (♀), chela (with pedicel) 4.4 × (♂), 4.0–4.1 × (♀) longer than broad, hand long and cylindrical, 1.6 × (♂), 2.1 × (♀) longer than deep, movable finger 1.2 × (♂), 1.1 × (♀) longer than hand. Femur with 2 long tactile setae situated in basal half (Fig. 2). Patella with three long lyrifissures situated dorsally near pedicel (Fig. 2). Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Fig. 3); *eb* and *esb* situated basally; *est* clearly in basal half of fixed finger, situated closer to *eb* and *esb* than to *et*; trichobothria *ib*, *isb*, *ist* and *it* grouped sub-basally, with *ib* separated from others; ca 4–5 microsetae (chemosensory setae) present on fixed finger distal to *et*; trichobothria of movable

finger situated in basal half of finger; *st* situated closer to chelal finger margin than *b*, *sb* and *t*; microsetae (chemosensory setae) not present on movable finger. Venom apparatus present in both chelal fingers, venom ducts very short, terminating in nodus ramosus almost immediately. Chelal teeth retrorse with obvious pointed tips; fixed finger with 18 (♂, ♀) teeth; movable finger with 18 (♂, ♀) teeth; accessory teeth absent.

Cephalothorax: Carapace sub-rectangular (Fig. 1); with 1 pair of flat, corneate eyes situated near anterior margin of carapace, posterior pair missing; generally with 20 setae, including 4 near anterior margin and 4 near posterior margin; without furrows; with 4 pairs of lyrifissures. Manducatory process with 1 long distal, 1 long sub-distal and very small internal, sub-oral seta; remainder of maxilla with 8–9 setae. Chaetotaxy of coxae I–IV: 6: 6: 4: 3–4.

Abdomen: Pleural membrane longitudinally striate. Tergites and sternites apparently without medial suture. Tergal chaetotaxy: ♂, ♀, 6: 4–6: 4–6: 5–6: 6: 6: 6: 6: 10: 10: 2; uniseriate; all setae acicular. Sternal chaetotaxy: ♂, 7–8: (0) 7–8 [2+2] (0): (2) 5–6 (2): 6: 6: 6: 6: 6: 10: 6: 2; ♀, 7–8: (0) 7–8 [2+2](0): (2) 5–6 (2): 6: 6: 6: 6: 6: 10: 6: 2; setae uniseriate and acuminate; glandular setae absent; anus not surrounded by sternite XI.

Genitalia: Male: with large lateral genital sacs; without dorsal anterior glands; cup-shaped ejaculatory canal atrium (Fig. 9). Female: with paired lateral cribriform plates and single median cribriform plate (Fig. 10).

Legs: Junction between femora and patellae I and II broad and apparently sub-mobile (Fig. 4); femur I approximately equal in size to patella I; femur + patella of leg IV 3.4–3.5 × (♂), 3.2–3.4 × (♀) longer than broad; femora I and II with 2 perpendicular lyrifissures situated sub-distally; tibiae III and IV with long sub-medial tactile seta (Fig. 5); metatarsi III and IV with long subbasal tactile seta (Fig. 5); metatarsus and tarsus stocky; subterminal tarsal setae arcuate and acute; arolium much longer than elaws, not divided (Figs. 4, 5).

Dimensions (mm): See Benedict & Malcolm (1978b).

Remarks.—*Oreolpium nymphum* was found by Benedict & Malcolm (1978b:124) to occur in “old mature bark taken from western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga menziesii*), and sugar pine (*Pinus lambertiana*) trees located in forests at elevations of 1,000 to 6,000 ft in western Oregon.” The species has not been subsequently reported in the primary literature and remains one of the least known of all North American pseudoscorpion species.

The written description of *O. nymphum* by Benedict & Malcolm (1978b) specifically mentions five setae on the cheliceral hand, but the accompanying illustration (Benedict & Malcolm 1978b:fig. 11) shows only four setae. We can confirm that five setae are indeed present in all specimens that were examined for this study.

Oreolpium semotum new species
Figs. 11–22

Material examined.—AUSTRALIA: *Tasmania*: Holotype male, The Needles Picnic Ground, Southwest National Park, 42°45'17"S, 146°24'36"E, 12–13 March 1997, under bark, F. Štáhlavský (TMAG). Paratype: 1 female, collected with holotype (TMAG).

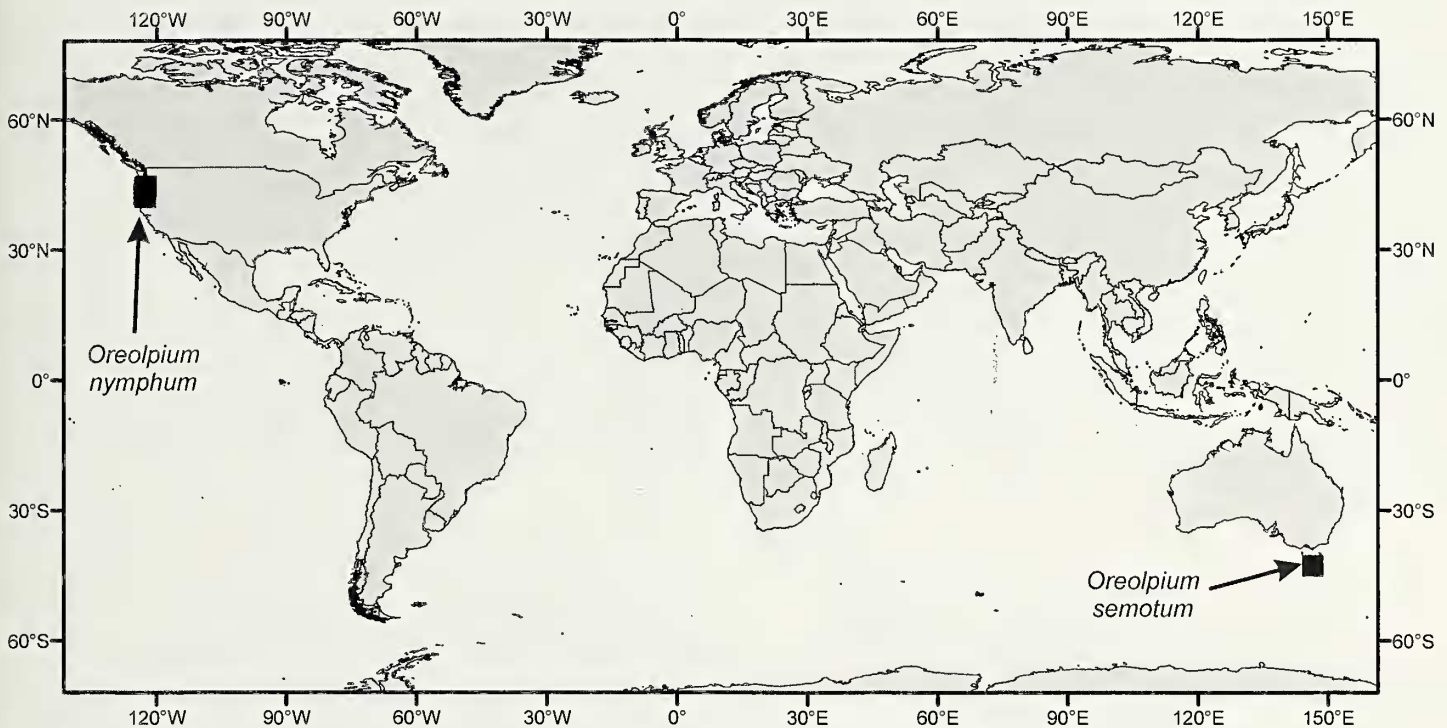


Figure 22.—Map depicting known distribution of species of *Oreolpium* (Garypinidae).

Etymology.—The specific epithet, which is Latin for “distant, far-off”, refers to the highly disjunct distribution of the two known species of *Oreolpium* (Fig. 22).

Diagnosis.—*Oreolpium semotum* is larger than *O. nymphum*, e.g., pedipalpal femur length 0.547 (♂), 0.563 (♀) mm in *O. semotum* compared with 0.33–0.35 (♂), 0.33–0.39 (♀) mm in *O. nymphum*, and chela (with pedicel) length 0.802 (♂), 0.845 (♀) mm in *O. semotum* compared with 0.56–0.59 (♂), 0.62–0.63 (♀) mm in *O. nymphum*.

Description.—*Adults*: body strongly flattened. Color of sclerotized portions generally very pale, pedipalps and anterior portion of carapace slightly darker.

Chelicera: With 5 setae on hand, all setae acuminate (Fig. 12); movable finger with 1 subdistal seta (Fig. 13); subterminal tooth of movable finger not bifurcate and not enlarged; with 3 lyrifissures, 2 on dorsal face, and 1 on ventral face; galea of ♂ with pointed tip and 1 small sub-medial ramus, of ♀ long with 3 terminal rami; rallum of 4 blades, the most distal blade with 6 large serrations on leading edge, middle blades with 2 serrations, basal blade with 1 serration (Fig. 14); serrula exterior with 17 blades; lamina exterior present, very thin.

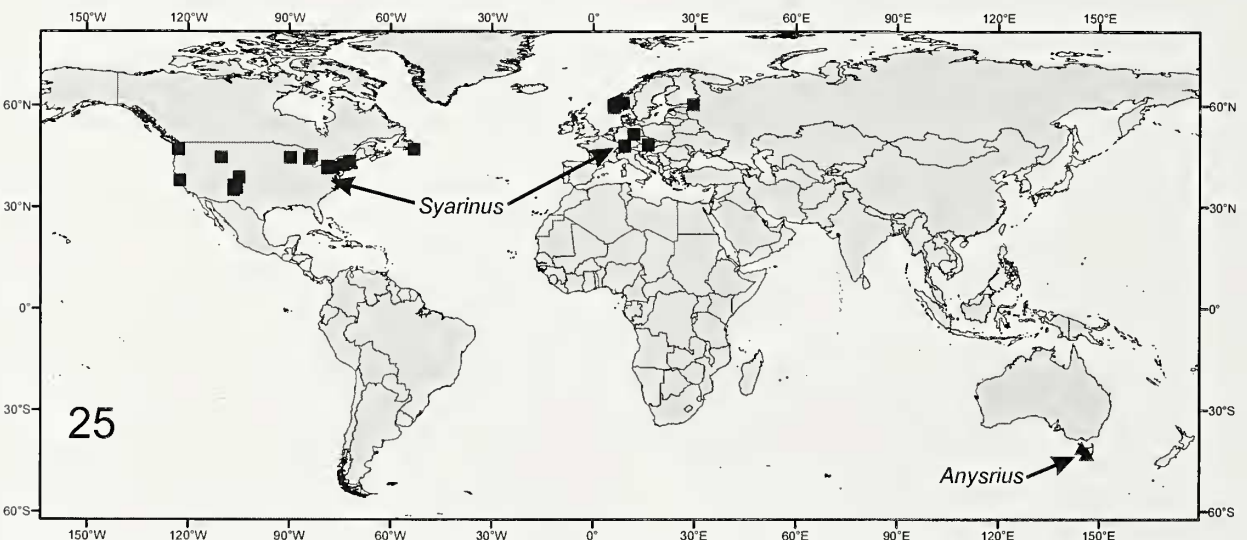
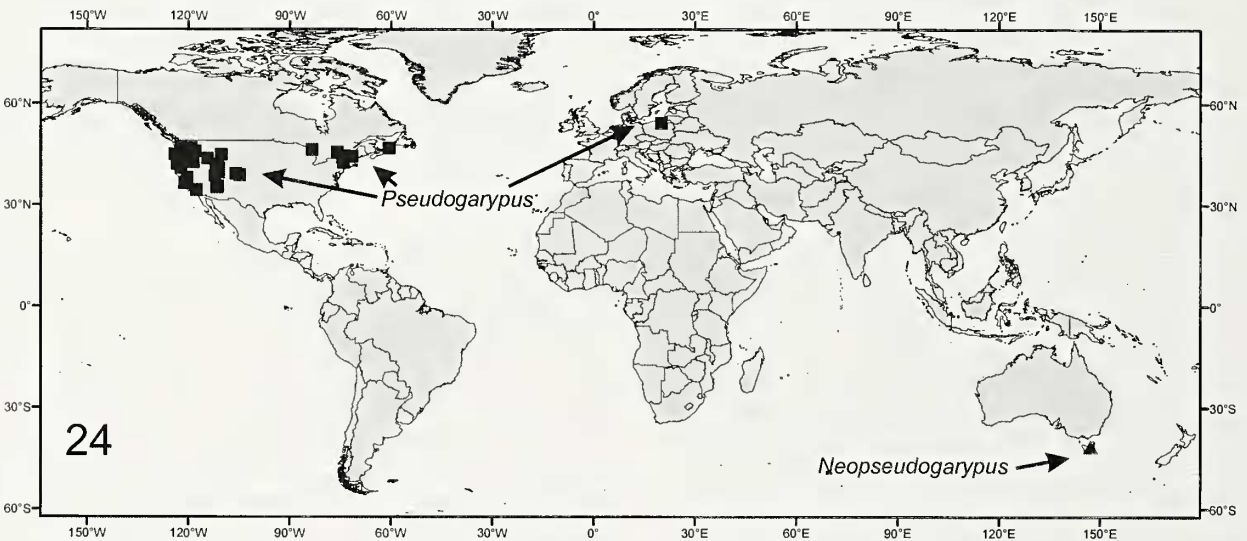
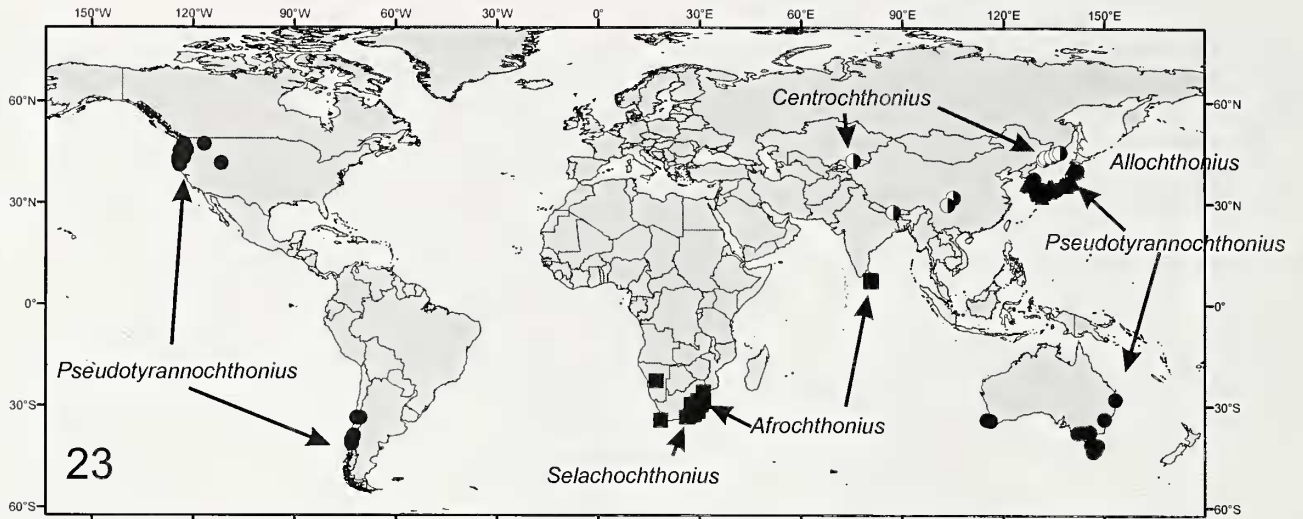
Pedipalp: Trochanter sparsely granulate on dorsal surface, femur, patella, and chela completely smooth (Fig. 15); setae very long and acicular; trochanter elongate, with faint tubercles, with roughened posterior tubercle; trochanter $2.11 \times$ (♂), $1.96 \times$ (♀), femur $4.05 \times$ (♂), $3.88 \times$ (♀), patella $2.72 \times$ (♂), $2.73 \times$ (♀), chela (with pedicel) $4.05 \times$ (♂), $4.04 \times$ (♀), chela (without pedicel) $3.78 \times$ (♂), $3.78 \times$ (♀) longer than broad, hand long and cylindrical, $2.08 \times$ (♂), $2.02 \times$ (♀) longer than broad, movable finger $0.84 \times$ (♂), $0.91 \times$ (♀) longer than hand. Femur with 1 long tactile seta situated in near middle of segment (Fig. 15). Patella with three lyrifissures situated dorsally near pedicel. Fixed chelal finger with 8 trichobothria,

movable chelal finger with 4 trichobothria (Fig. 16): *eb* and *esb* situated basally; *est* clearly in basal half of fixed finger, situated closer to *eb* and *esb* than to *et*; trichobothria *ib*, *isb*, *ist* and *it* grouped sub-basally, with *ib* slightly separated from others; ca. 6 microsetae (chemosensory setae) present on fixed finger distal to *et*; trichobothria of movable finger situated in basal half of finger; *st* situated closer to chelal finger margin than *b*, *sb* and *t*; microsetae (chemosensory setae) not present on movable finger. Venom apparatus present in both chelal fingers, venom ducts very short, terminating in nodus ramosus almost immediately. Chelal teeth rounded, basal teeth slightly flattened; fixed finger with 21 (♂), 22 (♀) teeth; movable finger with 21 (♂), 23 (♀) teeth; accessory teeth absent.

Cephalothorax: Carapace (Fig. 11) $1.45 \times$ (♂), $1.62 \times$ (♀) longer than broad; sub-rectangular but slightly narrowed anteriorly; with 1 pair of flat, corneate eyes situated near anterior margin of carapace, posterior pair missing; with 22 setae, including 4 near anterior margin and 4 near posterior margin; without furrows; with 5 pairs of lyrifissures. Manducatory process with 1 long distal, 1 long sub-distal and very small internal, sub-oral seta; remainder of maxilla with 5 setae. Chaetotaxy of coxae I–IV: 6: 5: 4: 3 (♂, ♀).

Abdomen: Pleural membrane longitudinally striate. Tergites and sternites with very faint medial suture. Tergal chaetotaxy: ♂, 4: 4: 4: 4: 6: 6: 6: 6: T1T2T1T: T1T2T1T: 2; ♀, 4: 4: 4: 4: 6: 6: 6: 6: T1T2T1T: T1T2T1T: 2; uniseriate; all setae acicular. Sternal chaetotaxy: ♂, 11: (0) 6 [2+2] (0): (2) 6 (2): 5: 5: 6: 6: 6: T1T2T1T: T1T2T1T: 2; ♀, 9: (0) 6 (0): (3) 8 (3): 6: 6: 6: 6: T1T2T1T: T1T2T1T: 2; setae uniseriate and acuminate; glandular setae absent; anus not surrounded by sternite XI.

Genitalia: Male: With large lateral genital sacs, without dorsal anterior glands; cup-shaped ejaculatory canal atrium (Fig. 20). Female: with paired lateral cribriform plates and single median cribriform plate (Fig. 21).



Figures 23–25.—Maps depicting known distribution of pseudoscorpion taxa with bipolar distributions based upon published records: 23. Pseudotyranochthoniidae; 24. Pseudogarypidae; 25. Syarininae (Syarinidae).

Legs: Junction between femora and patellae I and II broad and apparently sub-mobile (Fig. 18); femur I barely longer than patella I (Fig. 18); femur + patella of leg IV $3.08 \times$ (σ), $3.14 \times$ (φ) longer than broad; femora I and II with 2 perpendicular lyrifissures situated sub-distally; tibiae III and IV with long sub-medial tactile seta (Fig. 17); metatarsi III and IV with long subbasal tactile seta (Fig. 17); metatarsus and tarsus stocky (Fig. 17); subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided (Fig. 19).

Dimensions (mm).—*Male holotype:* Body length 2.48. Pedipalps: trochanter 0.325/0.154, femur 0.547/0.135, patella 0.454/0.167, chela (with pedicel) 0.802/0.198, chela (without pedicel) 0.750, hand length 0.411, movable finger length 0.346. Chelicera 0.170/0.090, movable finger length 0.131. Carapace 0.637/0.438; eye diameter 0.080. Leg I: femur 0.166/0.090, patella 0.141/0.093, tibia 0.203/0.046, metatarsus 0.077/0.045, tarsus 0.101/0.040. Leg IV: femur + patella 0.474/0.154, tibia 0.314/0.087, metatarsus 0.104/0.057, tarsus 0.146/0.046.

Female paratype: Body length 3.23. Pedipalps: trochanter 0.314/0.160, femur 0.563/0.145, patella 0.466/0.171, chela (with pedicel) 0.845/0.209, chela (without pedicel) 0.790, hand length 0.422, movable finger length 0.384. Chelicera 0.173/0.099, movable finger length 0.128. Carapace 0.704/0.435; eye diameter 0.051. Leg I: femur 0.166/0.098, patella 0.141/0.101, tibia 0.218/0.069, metatarsus 0.083/0.046, tarsus 0.109/0.043. Leg IV: femur + patella 0.503/0.160, tibia 0.288/0.090, metatarsus 0.104/0.058, tarsus 0.147/0.056.

Remarks.—*Oreolpium semotum* is currently known from only a single location in south-western Tasmania where it was taken from under the bark of a tree. Due to the highly localised distribution of this species, it is likely to represent a short-range endemic species (Harvey 2002).

DISCUSSION

Enormous disjunctions in the distribution of organisms that are apparently incapable of long-range dispersal are generally thought to represent vicariance events (Nelson & Platnick 1981). The presence of species of *Oreolpium* in Oregon and southern Tasmania (Fig. 22) is one such disjunction that can be explained by only one of two scenarios. The first postulates that one or both sites of occupancy are the result of recent inter-continental dispersal. The other hypothesis suggests that the common ancestor of both species was found on land masses that were once contiguous and that have since rafted away from each other due to sea-floor spreading and continental drift, taking their biological cargo with them. Harvey (1998b) nominated two pseudoscorpion groups that appeared to fit the criteria of the second theory, Pseudogarypidae and Syarininae, each with representatives in the northern hemisphere and in Tasmania (Figs. 24, 25). The two known pseudogarypid genera occur in totally different regions of the world, with the sole species of *Neopseudogarypus* Morris 1948, *N. scutellatus* Morris 1948, found in northern Tasmania, and Recent species of *Pseudogarypus* Ellingsen 1909 found in North America (Harvey 2009; Fig. 24). Several species of *Pseudogarypus* have also been described from Tertiary amber deposits collected in the Baltic region of northern Europe (see Harvey 2009), but no Recent

pseudogarypids are known from the region, suggesting that they have become locally extinct since the Eocene.

A third group, the chthoniid subfamily Pseudotyranochthoniidae, also has a very similar distribution pattern with representatives found in austral regions (southern Australia, southern Africa and Chile) and boreal regions (western North America, and Central and East Asia) (Fig. 23). There are five recognised pseudotyranochthoniid genera, with *Centrochthonius* and *Allochthonius* in Asia; *Pseudotyranochthonius* in Australia, Chile, western USA and East Asia, and *Afrochthonius* and *Selachochthonius* in southern Africa (Harvey 2009). The sole exception to the bipolar pattern is the presence of two species of *Afrochthonius* in Sri Lanka (Beier 1973), located in a tropical biome slightly north of the equator. This anomalous pattern is presumably best explained by the rafting of the Indian subcontinent from Gondwanaland during the late Cretaceous (e.g. Besse & Courtillot 1988; Smith et al. 1994; Scotese 2001).

We here propose a fourth pseudoscorpion group, the garypinid genus *Oreolpium*, which has a very similar distribution pattern to Syarininae and Pseudogarypidae, with *O. nymphi* found in northwestern USA and *O. semotum* found in southern Tasmania (Fig. 22). Whilst putative relatives of *Oreolpium* occur in Australia and South America, the monophyly of the genus seems assured as they share a number of reductive features (lack of dorsal glands in the male genitalia and lack of glandular setae on the medial sternites) that are present in all other garypinids without divided arolia, although the morphology of the male genitalia are presently unrecorded for *Teratolpium*.

Some water mite taxa seem to have the same pattern (Harvey 1998a). The hydryphantid genus *Tartarothyas* Viets 1934 occurs in Europe, North America and southern Australia (Cook 1974; Harvey 1987a, 1998a:fig. 5b; Smith & Cook 1999). Similarly, members of the *Panisellus* group (Hydryphantidae: Thyadinae) are found in Europe, North America, South Africa and Australia (Cook 1974; Harvey 1996; 1998a:fig. 5a). The subfamily Piersigiinae comprises two genera of which *Piersigia* Protz 1896 is found throughout the Holarctic region (Cook 1974) and *Austrapiersigia* Smit 1998 occurs in southeastern Australia (Harvey 1998a; Smit 1998). Finally, the pionid subfamily Huitfeldtiinae is found in Europe and North America (*Huitfeldtia* Thor 1898) and southwestern Australia (*Larri* Harvey 1996) (Cook 1974; Harvey 1998a:fig. 5d). These patterns are largely congruent and likely to have their origins in the same processes, which we here postulate to be the vicariant break-up of Pangaea which began during the Cretaceous.

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APPENDIX 1

Specimens of Garypinidae examined for this study.

- Aldabrinus* sp.: AUSTRALIA: *Western Australia*: Waychinicup Nature Reserve, S of Mt. Manypeaks, Surprise Gully, 34°54'11"S, 118°23'57"E, 13 March 2007, on reeds/grasses, M.L. Moir et al., 1 ♀ (WAM T79640); Mt. Hallowell, 35°00'34"S, 117°18'04"E, 6 November 2006, on plants, M.L. Moir, D. Jolly, 1 nymph (WAM T78899); Bremer Bay, Native Dog Beach, 34°27'17"S, 119°21'43"E, 21 November 2006, on plants, M.L. Moir, 2 nymphs (WAM T78821); Woodman Point Nature Reserve, Woodman Point, 32°07'50"S, 115°45'28"E, 1 September–4 November 1994, pitfall traps, J.M. Waldock, A.F. Longbottom, 1 ♀, 1 tritonymph (WAM T63240, T63242); Woodman Point Nature Reserve, Woodman Point, 32°07'50"S, 115°45'28"E, 4 November 1994–19 January 1995, pitfall traps, J.M. Waldock, M.S. Harvey, 1 ♀ (WAM T63241).
- Amblyolpium anatolicum* Beier 1967: TURKEY: *Isparta*: Egridir, 37°52'N, 30°51'E, 19 May 1965, F. Ressler, 1 ♀ (holotype) (NHMW).
- Amblyolpium franzi* Beier 1970: PORTUGAL: *Madeira*: Porto Santo, 33°03'N, 16°20'W, 13 April 1968, H. Franz, 1 ♂ (holotype) (NHMW).
- Amblyolpium novaeguineae* Beier 1971: PAPUA NEW GUINEA: *Morobe*: Heads Hump, Bulolo, 7°12'S, 146°39'E, 2 May 1970, B. Gray, 1 ♂, 1 ♀ (types) (NHMW); *Morobe*: Bulolo, 7°12'S, 146°39'E, 18 August 1970, B. Gray, 6 ♂, 2 ♀ (paratypes) (NHMW).
- Amblyolpium ruficeps* Beier 1966: NEW CALEDONIA: Niaouli forest near Col Boa, 21°16'S, 165°14'E, 11 August 1965, A. Kaltenbach, 1 ♂ (holotype) (NHMW).
- Amblyolpium* sp.: AUSTRALIA: *Western Australia*: Ravensthorpe Range Middle, 33°34'04.09"S, 120°02'51.05"E, 210 m, 28 May 2007, leaf litter, M.C. Leng, M.L. Moir, 1 ♀, 1 protonymph (WAM T86787); Ravensthorpe Range, Ravensthorpe Townsite (Site WAM 48), 33°34'04.09"S, 120°02'51.05"E, 8 September 2007, leaf litter, M.C. Leng, M. Lyons, 2 ♀ (WAM T81308); Mcdermid Rock, 32°01'S, 120°44'E, 27 September–3 October 1978, under litter, T.F. Houston et al., 1 ♀ (WAM 81/183).
- Galapagodin* *franzi* Beier 1978: ECUADOR: *Galápagos*: Galapagos Islands: Isla San Salvador (as Isla Santiago), 1°16'S, 90°42'E, 16 June 1975, H. Franz, 1 ♂ (paratype) (NHMW); Isla San Salvador (as Isla Santiago), 1°16'S, 90°42'E, 18 June 1975, H. Franz, 1 ♀ (paratype) (NHMW); Isla San Salvador (as Isla Santiago), 1°16'S,

90°42'E, 16 June 1975, H. Franz, 1 ♂ (holotype), 1 ♀ (allotype) (NHMW).

Galapagodin sp.: ECUADOR: *Galápagos*: Galapagos Islands: Rabida Island, 0°24'S, 90°42'W, 15 May 1983, Y. Lubin 1983, 1 ♂, 1 tritonymph (MCZ, Muchmore slide no. WM6317.01001-2).

Garypinidius capensis (Ellingsen 1912): SOUTH AFRICA: *Western Cape Province*: de Hoop Nature Reserve, Lakkerwater Rd., 32°24'12"S, 20°33'09"E, 26 September 2007, C. Haddad, 1 ♂ (WAM T86745).

Garypinus asper Beier 1955: LEBANON: *Mont-Liban*: Ouadi el Fouar (as Anteljas-Fluss), 33°59'N, 35°35'E, 11 September 1952, K. Christiansen, 1 specimen (paratype) (NHMW).

Garypinus dimidiatus (L. Koch 1873): GREECE: *Crete*: Ákra Sideros (as Sideros), 35°19'N, 26°19'E, 5 May 1965, E. Kritscher, O. Paget and Bilek, 1 specimen (NHMW); Paximadia Island, 35°00'N, 24°35'E, 30 April 1965, E. Kritscher, O. Paget and Bilek, 13 specimens (NHMW); Aghios Nikolaos, 34°52'N, 32°45'E, 8 May 1965, E. Kritscher, O. Paget and Bilek, 2 specimens (NHMW). TURKEY: *Antalya*: Antalya, 36°55'N, 30°41'E, 15 May 1965, F. Ressler, 2 specimens (NHMW); *İçel*: Anamur, 36°05'N, 32°50'E, 21 April 1963, F. Ressler, 35 specimens (NHMW); *Muğla*: Marmaris, 36°51'N, 28°16'E, 12 April 1966, Franz, 5 specimens (NHMW).

Garypinus afghanicus minor Beier 1959: AFGHANISTAN: *Kandahar*: Dalah near Arghandab, 31°39'N, 65°39'E, 6 May 1958, K. Lindberg, 1 ♀ (paratype) (NHMW).

Hemisolinus helenae Beier 1977: ST. HELENA: east Prosperous Bay Plain, 15°57'S, 05°39'W, 4 January 1966, Terunrenlop, 1 ♂ (paratype) (NHMW); east Prosperous Bay Plain, 15°57'S, 05°39'W, 5 February 1967, 1 ♂, 1 ♀ (paratypes) (NHMW).

Neoamblyolpium alienum Hoff 1956: USA: *New Mexico*: Valencia County: Mt. Taylor, near Grants, 35°14'N, 107°36'W, 7,500 ft, 20 October 1951, pinyon litter, C.C. Hoff, 1 ♂ (holotype) (AMNH, Hoff slide no. S-1801.1); Torrance County: 1 mi W of Mountainair, 34°31'N, 106°15'W, 6,800 ft, 15 September 1954, in dead yucca, C.C. Hoff, 1 ♀ (allotype, Hoff slide no. S-2165.6), 1 ♂ (paratype) (Hoff slide no. S-2165.7), 1 ♀ (paratype) (Hoff slide no. S-2165.10) (AMNH); San Miguel County: 2 mi S of Villanueva, 35°14'N, 105°22'W, 6,600 ft, 3 September 1954, juniper litter, C.C. Hoff, 1 ♀ (paratype) (AMNH, Hoff slide no. S-2147.1); Santa Fe County: near Edgewood, 35°03'N, 106°11'W, 6,700 ft, 27 September 1954, pinyon litter, C.C. Hoff, 1 deutonymph (paratype) (AMNH, Hoff slide no. S-1916); *Colorado*: Garfield County: 4 mi E of Glenwood Springs, 39°31'N, 107°19'W, 6,000 ft, 1 September 1958, C.C. Hoff, 1 ♂ (AMNH, Hoff slide no. S-3731.2); Chaffee County: 6 mi NW of Salida, 38°35'N, 106°05'W, 4–5 September 1958, C.C. Hoff, 1 ♀ (AMNH, Hoff slide no. S-748.1); Larimer County: 30 mi W of Fort Collins, 40°34'N, 105°38'W, 6,400 ft, 12 August 1958, trunk debris, yellow pine, C.C. Hoff, 1 ♂ (MCZ, Hoff slide no. S-3684.3).

Neomimniza divisa Beier 1930: CHILE: *Región Metropolitana*: Farellones, 33°18'S, 70°15'W, 10 November 1959, 1 ♂ (NHMW); Farellones, 33°18'S, 70°15'W, 27 September 1959, 1 specimen (NHMW); *Bio-Bío*: Rinconada, 36°49'S, 72°33'W, 20 March 1959, Noodt, 1 ♂ (NHMW); Rinconada, 36°49'S, 72°33'W, 28 July 1959, Noodt, 1 ♂ (NHMW).

Neomimniza halophila Beier 1964: CHILE: *Coquimbo*: Punta Taetinos, 29°49'S, 71°17'W, 12 km N of La Serena, 31 October 1954, Kuschel, 1 ♀ (NHMW).

Neomimniza sp.: CHILE: *Valparaiso*: Petorca: Los Molles, Route 5, km 188, 32°14'S, 71°30'W, 10 m, 10 January 1995, Platnick, Catley, Silva, 1 ♂ (AMNH).

Oreolpium nympium Benedict and Malcolm 1978: see text.

Oreolpium semotum new species: see text.

Paraldabrinus novaecaledoniae Beier 1966: NEW CALEDONIA: Gorge de Ndokoa, 21°19'S, 165°16'E, between Pic Adio and Dent de Poya, 11 August 1965, A. Kaltenbach, 1 ♂, 2 ♀ (types) (NHMW).

Protogarypinus dissimilis Beier 1975: AUSTRALIA: *South Australia*: Flinders Ranges, Mt. Remarkable National Park, Alligator

Gorge, 32°50'S, 138°02'E, 24 March 1967, T.G. Wood, R.W. George, 2 ♂, 1 ♀, 5 nymphs (paratypes) (NHMW); Mt. Remarkable National Park, Mambray Creek camping ground, 32°50'19"S, 138°02'13"E, 22 November 2002, under rocks, M.S. Harvey, M.E. Blossfelds, 1 ♂ (WAM T88509).

Protogarypinus gigantens Beier 1954: AUSTRALIA: *Western Australia*: Walpole-Nornalup National Park, The Tingle Tree, 34°58'58"S, 116°47'09"E, 12 February 2002, under bark of *Eucalyptus diversicolor*, M.S. Harvey, M.E. Blossfelds, F. Harvey, E. Harvey, 5 ♂, 3 ♀ (with brood-sacs), 1 tritonymph, 2 deutonymphs, 7 protonymphs (WAM T65459).

Pseudogarypinus cooperi Muchmore 1980: USA: *California*: Riverside County: James Reserve, Lake Fulmor, 33°48'33"N, 116°46'30"W, 1690 m, 29 June 2002, under rocks, M.S. Harvey, 3 ♂, 3 ♀, 1 tritonymph (WAM T63230, T63231); Los Angeles County: Santa Monica Mts., Piuma Road, 34°04'33"N, 118°41'25"W, 23 June 2002, under stones, M.S. Harvey, 1 ♂ (WAM T63232); Los Angeles County: Devils Punch Bowl, 34°25'N, 117°51'W, 22 May 2002, underside of rocks, G. Lowe, 2 ♂ (WAM T63243); Los Angeles County: 1 mi NE of Camp Valcrest, Angelas Crest Highway, 34°21'N, 117°59'W, 27 January 1982, under logs embedded in moist soil, G. Lowe, 1 ♂ (WAM T63244); San Bernardino County: Mt. Baldy Road, Manker Flats, 34°16'N, 117°38'W, 15 April 1987, under rocks, G. Lowe, 1 ♀ (WAM T63245).

Pseudogarypinus costaricensis Beier 1931: COSTA RICA: *Cartago*: Irazú, 9°59'N, 83°51'W, 25 May 1930, 2 specimens ("Typen") (NHMW); Irazú, 9°59'N, 83°51'W, 20 May 1930, 1 ♂ (paratype) (NHMW); Irazú, 9°59'N, 83°51'W, 26 May 1930, 2 ♂, 4 ♀ (paratypes) (NHMW).

Pseudogarypinus frontalis (Banks 1909): USA: *California*: Los Angeles County: Toyon Canyon, Santa Catalina Island, 33°22'N, 118°21'W, 1 September 1984, G. Lowe, 1 ♂ (WAM T75555); *Colorado*: Larimer County: Rist Canyon, Fort Collins, 40°38'N, 105°12'W, 6,000 ft, 20 July 1956, C.C. Hoff, 1 ♂ (AMNH, Hoff slide no. S-1057.1); Mesa Verde National Park, 37°14'N, 108°29'W, 7,000 ft, 1953, P. Van Cleave, 1 ♀ (AMNH, Hoff slide no. S-2183.3).

Serianus arboricola (Chamberlin 1923): MEXICO: *Baja California Sur*: Isla San Esteban, 28°42'N, 112°36'W, 19 April 1921, under mesquite bark, J.C. Chamberlin, 1 ♂ (holotype), 2 ♂, 1 ♀ (paratypes) (CAS, holotype, Type No. 1284; paratypes JC-172.01001-3); Isla Cerralvo [as Ceralbo Island], 24°14'N, 109°51'W, Rufo's ranch house, 7 June 1921, under bark, J.C. Chamberlin, 1 ♂, 1 ♀ (paratypes) (CAS, JC-171.01001, 2); north end of Isla San Jose (as San Josef Island), near lagoon, ca. 25°02'N, 110°43'W, 28 May 1921, under bark, J.C. Chamberlin, 3 ♂, 1 ♀ (paratypes) (CAS, JC-174.01004); *Sonora*: San Pedro Nolasco, 27°58'N, 111°23'W, 17 April 1921, under *Acacia* bark, J.C. Chamberlin, 1 ♂ (paratype) (CAS, JC-173.01001).

Serianus argentinae Muchmore 1981: ARGENTINA: *Buenos Aires*: Punta Piedras, 35°24'S, 57°06'W, 1 May 1942, J.A. Rosas Costa, 1 ♂, 2 ♀ (paratypes of *S. minutus* Hoff 1950) (AMNH, Hoff slide no. 6278-S-1054.5-7).

Serianus biimpresus (Simon 1890): MOROCCO: *Nador*: Kebdana, Granja del Muluye, 35°07'N, 02°20'W, July 1952, 3 ♂, 3 ♀ (NHMW).

Serianus boliviannus (Beier 1939): BOLIVIA: *Oruro*: Pazña, 18°36'S, 66°55'W, 14 August 1937, P. Sladen, 2 specimens (paratypes) (NHMW); Pazña, 18°36'S, 66°55'W, 14 August 1937, P. Sladen, 1 ♂ (paratype) (NHMW).

Serianus carolinensis Muchmore 1968: USA: *North Carolina*: Carteret County: near Beaufort, 34°43'N, 76°40'W, March–July 1966, P. Weygoldt, 1 ♂ (holotype), 5 ♂, 6 ♀ (paratypes) (AMNH, Muchmore slide no. WM-917.01010, holotype; WM 917.01005, 06, 08, 11, 16, ♂♂; WM 917.01001-04, 07, 09, ♀♀).

Serianus dolosus Hoff 1956: USA: *New Mexico*: Santa Fe County: 8 miles N of Golden, Ortiz Mountains, 35°23'N, 106°13'W, 7,000 ft, no date, C.C. Hoff, 1 ♂ (holotype) (AMNH, Hoff slide no. S-1883.7); Santa Fe County: 8 mi N of Golden, Ortiz Mountains, 35°23'N, 106°13'W, 7,000 ft, 11 August 1952, C.C. Hoff, 1 ♂ (paratype

(AMNH, Hoff slide no. S-1883.1); Bernalillo County: Cedro Canyon, Manzano Mountains, east of Albuquerque, 35°04'N, 106°23'W, 6,600 ft, no date, C.C. Hoff, 1 ♀ (allotype), 3 deutonymphs (paratypes) (AMNH, Hoff slide no. S-1503.1, 4-6); Bernalillo County: west side of Sandia Mountains, ca. 35°14'N, 106°30'W, 6,400 ft, May 1952, C.C. Hoff, 1 ♂ (paratype) (AMNH, Hoff slide no. S-1727).

Serianus galapagoensis Beier 1978: ECUADOR: *Galápagos*: Galapagos Islands: Isla Santa Fe, 0°49'S, 90°04'W, 15 May 1975, H. Franz, 1 ♂ (holotype), 1 ♀ (allotype) (NHMW); Galapagos Islands: Island Santa Fe, 0°49'S, 90°04'W, 15 May 1975, H. Franz, 6 specimens (paratypes) (NHMW); Galapagos Islands: Isla Pinzón, 0°36'S, 90°40'W, 22 June 1975, H. Franz, 1 ♂ (paratype) (NHMW); Galapagos Islands: Island Pinzón, 0°36'S, 90°40'W, 22 June 1975, H. Franz, 1 ♀ (paratype) (NHMW).

Serianus gratus Hoff 1964: JAMAICA: *St Thomas Parish*: 2 miles W of Morant Bay, 17°53'N, 76°27'W, 25 May 1956, C.C. Hoff, 1 ♂ (paratype) (AMNH, Hoff slide no. S-3096.1); Morant Point, 17°55'N, 76°10'W, 6 May 1956, C.C. Hoff, 1 ♀ (paratype) (AMNH, Hoff slide no. S-2966); *St Catherine Parish*: Port Henderson, 17°57'N, 76°53'W, 4 May 1956, C.C. Hoff, 1 ♀ (paratype) (AMNH, Hoff slide no. S-2952.6); Port Henderson, 17°57'N, 76°53'W, 4 May 1956, C.C. Hoff, 1 tritonymph (paratype) (AMNH, Hoff slide no. S-2953.5.1).

Serianus litoralis (Chamberlin 1923): MEXICO: *Baja California Sur*: Golfo de California, Isla Monserrat (as Monserrate Island), 25°41'N, 111°03'W, 25 May 1921, on beach under stone, J.C. Chamberlin, 1 ♂ (holotype) (CAS, Type No. 1283, JC-161.03001).

Serianus minutus (Banks 1908): USA: *Texas*: Travis County: Austin, 30°16'N, 97°45'W, no date, nest of *Ecton caecium* (now *Labidus coecium*), C.T. Brues, 1 ♂, 1 ♀, 1 nymph (syntypes) (MCZ).

Serianus patagonicus (Ellingsen 1904): CHILE: *Los Lagos*: Lago Toro, 40°45'S, 72°18'W, 18 February 1957, Kuschel, 1 ♀ (NHMW); *Magallanes y Antártica Chile*: Puerto Williams, 54°56'S, 67°37'W, 9 February 1959, Kuschel, 1 ♂, 1 ♀ (NHMW); *Coquimbo*: 22 mi S of La Serena, ca. 30°14'S, 71°14'W, 9 December 1950, Ross and Michelbacher, 1 ♀ (NHMW); ARGENTINA: *Rio Negro*: El Bolsón, 41°58'S, 71°31'W, 27 July 1961, Topál, 9 specimens (NHMW); El Bolsón, Cerro Piltriquitrón, 41°58'S, 71°29'W, 22 August 1961, Topál, 16 specimens (NHMW); Laguna El Trebol (as Lago Trebol), San Carlos de Bariloche (as Bariloche), 41°04'S, 71°30'W, 23 November 1950, P. Wygodzinsky, 1 ♂ (NHMW).

Serianus salomonensis Beier 1966: SOLOMON ISLANDS: Guadalcanal, Kukum, 9°26'S, 159°59'E, 9 December 1965–13 January 1966, P. Greenslade, 1 ♂ (holotype) (NHMW).

Serianus serianus (Chamberlin 1923): MEXICO: *Sonora*: Golfo de California, Isla Pelicano (as Pelican Island), Bahía de Kino, 28°49'N, 111°58'W, 5 July 1921, under stone, J.C. Chamberlin, 1 ♂ (holotype) (CAS (Type No. 1279); Golfo de California, Isla Pelicano (as Pelican Island), Bahía de Kino, 28°49'N, 111°58'W, 5 July 1921, J.C. Chamberlin, 2 ♂, 2 ♀ (paratypes) (CAS, JC-164.01001-4); *Baja California Sur*: Golfo de California, Isla Ángel de la Guarda, opposite Isla Estanque (as Pond Island), 29°03'N, 113°06'W, 30 June 1921, J.C. Chamberlin, 1 ♂ (CAS, JC-165.01001-4).

Serianus solus (Chamberlin 1923): MEXICO: *Baja California Sur*: Golfo de California, South Islas Santa Inés, 27°03'N, 111°54'W, 13 May 1921, under stone, J.C. Chamberlin, 1 ♂ (holotype) (CAS, Type no. 1281); Golfo de California, South Islas Santa Inés, 27°03'N, 111°54'W, 13 May 1921, under stone, J.C. Chamberlin, 2 ♂, 1 ♀ (paratypes) (CAS, JC-169.01001-03); Golfo de California, Isla Ballena, near Espiritu Santo, 24°29'N, 110°24'W, 9 June 1921, under stone, J.C. Chamberlin, 1 ♀ (paratype) (CAS, JC-168.01001); *Baja California Norte*: Golfo de California, Isla Ángel de la Guarda, Palm Canyon, ca. 29°15'N, 113°20'W, 3 May 1921, J.C. Chamberlin, 1 specimen (paratype) (CAS, JC-167.01001).

Serianus validus (Beier 1971): IRAN: *Hormozgan*: 30 km NW of Bandar Abbas, ca. 27°22'N, 56°03'E, 4 April 1970, Rcssl and Bilek, 4 ♀ (syntypes) (NHMW).

Serianus sp.: USA: *California*: Los Angeles County: Santa Monica Mts, Piuma Road, 34°04'33"N, 118°41'25"W, 23 June 2002, under stones, M.S. Harvey, 1 ♂ (WAM T63229).

Solinus corticola (Chamberlin 1923): MEXICO: *Baja California Sur*: La Paz, 24°08'N, 110°17'W, 12 April 1921, under palo verde bark, J.C. Chamberlin, 1 ♂ (holotype) (CAS, Type No. 1277); La Paz, 24°08'N, 110°17'W, 12 April 1921, under palo verde bark, J.C. Chamberlin, 1 ♂, 1 ♀ (paratypes) (CAS, JC-175.01001, 2); Mulegé, 26°53'N, 111°59'W, 14 May 1921, J.C. Chamberlin, 3 ♂, 3 ♀ (paratypes) (CAS, JC-179.01001-4, 6, 7); Bahía Agua Verde, 25°31'N, 111°04'W, 26 May 1921, J.C. Chamberlin, 1 ♂ (paratype) (CAS, JC-182.01001); *Baja California Norte*: Bahía San Luis Gonzales, 29°46'N, 114°21'W, 27 April 1921, J.C. Chamberlin, 3 ♀ (paratypes) (CAS, JC-180.01001-3); *Sonora*: Bahía San Pedro, 28°03'N, 111°14'W, 7 July 1921, under bark, J.C. Chamberlin, 4 ♀ (paratypes) (CAS, JC-177.01001-4); Guaymas, 27°56'N, 110°54'W, 14 April 1921, under mesquite bark, J.C. Chamberlin, 1 ♂ (paratype) (CAS, JC-178.01001); SE. corner of Isla Tiburón (as Tiburon Island), near Punta Monumento (as Monument Point), 28°45'N, 112°19'W, 4 July 1921, J.C. Chamberlin, 1 ♀ (paratype) (CAS, JC-183.01001).

Solinus rhodius Beier 1966: GREECE: *Dodekanisos*: Rhodos Island: between Rhodos and Kritica [location not traced], 11 April 1966, H. Franz, 1 ♀ (holotype) (NHMW).

Solinus sp. 1: USA: *New Mexico*: Dona Ana County: Mt Summerford, Jornada del Muerto, 25 mi NNE. of Las Cruces, 32°31'N, 106°49'W, 11 October 1982, G. Ettershank, 3 ♂, 2 ♀, 3 nymphs (WAM T54076).

Solinus sp. 2: AUSTRALIA: *Western Australia*: Rottneest Island, ca 32°00'S, 115°36'E, 24 August, 2003, F. Štáhlavský, 1 ♂, 1 ♀, 1 nymph (WAM T54068, T81113); 67 km S of Pannawonica, 22°15'47"S, 116°15'31"E, 21 June 2007, under bark, P. Runham, J. Adcroft, 1 ♂, 1 ♀ (WAM T81353).

Teratolpium andinum Beier 1959: PERU: *Ancash*: Laguna Jahua-cocha (as Jahua-Kocha), 10°14'S, 76°58'W, 2 July 1954, H. Höffler, 2 ♂ (syntypes) (NHMW).

Thaumatolpium kuscheli Beier 1964: CHILE: *Coquimbo*: Los Choros, 29°19'S, 71°21'W, 3 October 1952, Kuschel, 1 ♂, 2 ♀, 1 tritonymph (paratypes) (NHMW); *Atacama*: Carrizal Bajo, 28°05'S, 71°09'W, 19 September 1952, Kuschel, 2 ♀ (paratypes) (NHMW).

Thaumatolpium robustius Beier 1964: CHILE: *Atacama*: Huasco, 28°28'S, 71°11'W, 11 October 1957, Kuschel, 1 ♂ (paratype) (NHMW).

Thaumatolpium sp.: CHILE: *Coquimbo*: Elqui, 20 km N. of La Serena, Route 5, km 491, 29°46'S, 71°20'W, 120 m, 8 February 1994, N. Platnick, K. Catley, P. Calderón, R.T. Allen, 1 ♂, 1 ♀ (AMNH).